B R E V I O R A

Museum of Comparative Zoology

US ISSN 0006-9698

Cambridge, Mass. 28 December 1973 Number 416

MUSEUMS AND BIOLOGICAL LABORATORIES

Ernst Mayr

When Professor Crompton invited me to give a short after-dinner address on the occasion of the opening of the wing, he added that he wanted to publish it. This posed a challenge to me to come up with something that is worth being printed. However, I consider this invitation less of a challenge than a welcome opportunity to present some thoughts on museums and their role in science.

The speakers this afternoon have rightly emphasized that the opening of the Museum's laboratory wing is a milestone in the history of the MCZ. It is an occasion to look back to the days of its founding and an occasion to look forward to its future. It is also an occasion to ask some searching questions. For instance, someone unacquainted with biology and intolerant of anything but his own hobbyhorse, might ask, "Why do we still need natural history museums?" Such a question is quite legitimate, for I am a strong believer in the principle that the legitimacy and continuing value of traditional rituals and institutions should be challenged from time to time. How, then, would we answer this question?

The role of museums in science, and their image in our society, is changing from decade to decade. When natural history was revived during the Renaissance and during the 17th and 18th centuries, it expressed at first man's wonder and bewilderment at the enormous variety of life. This "diversity of nature" has been a key concept in man's world picture from the days when the Lord told Adam to give names to all the creatures in the field to the present day when species diversity is one of the central themes in the work of the ecologists.

The rich treasures brought back from exotic countries in the 18th and 19th centuries by voyages and expeditions, combined

with the steady rise of a more and more scientific attitude in Western man, resulted in a changed concept of organic diversity. No longer was it merely a source of wonder but naturalists began to raise questions concerning the reasons for the existence of so many and such strange organisms and about the meaning of their peculiar distribution in Asia, Africa, the Americas, and Australia.

I am not claiming that naturalists were always interested only in the most lofty generalizations because there was hardly a naturalist who was not also infected by that strange virus called the collector's fever. Perhaps no one was more affected by this disease than the founder of the MCZ, Louis Agassiz, who cheerfully pawned everything he owned in order to acquire more specimens. Indeed, it is said that only a few decades ago this Museum still had unopened boxes of collections from Louis Agassiz's days.

These collections, however, were not merely the useless gatherings of pack rats. It was their study which helped bring about a conceptual revolution — the establishment by Darwin of the theory of evolution, to a considerable extent based on Darwin's own researches during the voyage of the "Beagle" and the subsequent working out of his collections. And the proposal of the theory of evolution was only one of several such conceptual revolutions in the history of natural history.

The diversity of nature has been considered, ever since Darwin, a documentation of the course of evolution. Research in the pathway of evolution indeed turned out to be an incredibly rich gold mine. And it was the museums that established and maintained leadership in this type of research. The historians of biology have clearly determined that the crucial advances in the modern interpretation of species, of the process of speciation, and of the problems of adaptation were made by systematists.

One of the greatest conceptual revolutions in biology, the replacement of essentialism by population thinking, was introduced into biology by museum systematists. From systematics it was brought into genetics by workers like Chetverikov, Timofeeff-Ressovsky, Dobzhansky, Sumner, and Edgar Anderson, all of whom had either been trained as systematists or had worked closely with systematists.

Again and again the students in special branches of biology such as biogeography have gone back to systematics for material and for novel ideas.

The speakers this afternoon have documented sufficiently how

important museums and systematics are. But this raises another question, which is: "Why is systematics so important?" And this leads right on to the further question of the position of systematics in biology as a whole. I pointed out a dozen years ago that, in spite of all of its unitary characteristics, biology really has two major divisions; indeed, one can speak of two biologies. In the first one, functional biology, "How?" questions are the important ones. This is the biology that deals with physiological mechanisms, developmental mechanisms, metabolic pathways, and with the chemical and physical basis of all aspects of life. To use modern technical language, this part of biology ultimately deals both with the translation (decoding) of genetic programs into components of the phenotype and with their subsequent functioning. This type of biology played a decisive role in disproving conclusively all vitalistic notions and in establishing firmly that nothing happens in organisms that is in conflict with the laws of chemistry and physics. This is the biology which interprets all cellular and developmental processes, both the normal ones and such abnormal ones as the origin of cancer.

The other biology is interested in the genetic programs themselves, dealing with their origin and evolutionary change. It continuously asks "Why?" questions, for instance:

Why is there such a diversity of animal and plant life?

Why are there two sexes in most species of organisms?

Why is the old faunal element of South America seemingly related to that of Africa while the new one is related to that of North America?

Why are the faunas of some areas rich in species and those of others poor?

Why are certain organisms very similar to each other, while others are utterly different?

In the last analysis, all questions in this part of biology are evolutionary questions, and museum-based collections are ultimately needed to find the facts for posing and answering all of these questions.

At this point some of the more perceptive members of this audience will think that I have painted myself into a corner. Why, they will say, do you need a laboratory wing when the method of systematic and evolutionary biology is the comparative method, based on observations? Why do you have to perform experiments?

The explanation for the seeming contradiction is that I have told only part of the story. Systematics, as it was defined by

G. G. Simpson, "is the scientific study of the kinds and diversity of organisms *and of any and all relationships among them.*"

This definition has two consequences: First, it means that the systematist also must ask "How?" questions, like "How do species multiply?" or "How does an evolutionary line acquire new adaptations?", or "How did the phyletic line leading to Man emerge from the anthropoid condition?".

All these evolutionary questions deal with the history of changes, and, most importantly, with the causation of changes. Translated into Darwinian language, each of the questions I have just posed can also be stated in the following terms:

"What were the selection pressures responsible for causing the stated evolutionary changes?"

Not only is it often necessary to make use of experiments to answer this type of question, but, more importantly, many of such questions cannot be answered — or at least not completely — simply by the study of preserved material.

Since the investigation of diversity includes the study of relationships, organisms must be studied alive and in the field. In the last 150 years there has hardly been an outstanding systematist who was not, at the same time, an outstanding field naturalist, and who could not have been called, with equal justification, an ecologist or a student of behavior. This is, by no means, a recent development. Re-reading recently Louis Agassiz's "Essay on Classification," published in 1857, I was astonished to find what stress he placed on the study of the "habits of animals," as he put it.

"Without a thorough knowledge of the habits of animals," he said, "it will never be possible to determine what species are and what not." Today we would call this a biological species concept. He goes on to say that we want to find out "how far animals related by their structure are similar in their habits, and how far these habits are the expression of their structure." He continues, "How interesting would be a comparative study of the mode of life of closely allied species." Indeed, Agassiz proposes a program of study which is virtually identical with that of the founders of ethology more than 50 years later: "The more I learn about the resemblances between species of the same genus and of the same family . . . the more am I struck with the similarity in the very movements, the general habits, and even in the intonation of the voices of animals belonging to the same family . . . a minute study of these habits, of these movements,

of the voice of animals cannot fail, therefore, to throw additional light upon their affinities."

An interest in the behavior of animals is still a tradition in the MCZ, more than 100 years later. Half of my Ph.D. students in the last 20 years, for example, did their theses on problems of behavior. One of the outstanding characteristics of the so-called new systematics is the concern with the attributes of the living animal. Variation, adaptation, speciation, and evolutionary change cannot be fully understood unless the field work is supplemented by experimental research in population genetics, the analysis of protein and chromosomal variation in populations, the study of the relations between adaptation and functional morphology, to give merely a few examples. Laboratories for such studies are a major component of the new wing. Environmental physiology, another aspect of animal adaptation of great interest to the evolutionist, is being studied at the Countway Laboratories of the Concord Field Station.

The outside world has been largely oblivious to these developments and, I am sorry to say, unfortunately so have also many systematists. For the modern systematist, however, all this seems to be a perfectly natural development. Anyone who has read books like Huxley's *New Systematics* (1940) or my own *Systematics and the Origin of Species* (1942) knows to what an extent all these mentioned activities have been part of systematics for at least 30 years. The new wing gives us an opportunity to help correct the false image about museums which is still widely held, and replace it by the new concept, the beginnings of which were already outlined by Louis Agassiz 116 years ago.

The new wing signals to the outside world that the MCZ is not merely a repository of collections but a biological research institute that differs from the other laboratories in the Biological Laboratories only in the nature of the subject matter. While the emphasis in much of the Biological Laboratories is on cells and the molecular constituents of cells, the major emphasis in the MCZ is on the whole organism, on the diversity of organisms and on their evolution. Since closest contact between the two groups of investigators is of the utmost mutual benefit to both of them, the organization of the Department of Biology was modified in recent years in order to integrate the staffs of the two groups. Research and teaching are the objectives of both of them.

In this day and age science is no longer conducted merely for its own sake. Science is no longer the tenant of an ivory-tower.

Without wanting to minimize in any way the indispensability of basic science, we now realize that the scientist also has social obligations. When optimistically inclined he will say that he is helping to build a better world; when pessimistically inclined he will say he is trying to prevent a further deterioration of this world.

But he cannot do this unless he has a sound understanding of Man and of the world in which he lives. And it is precisely the study of diversity and of evolutionary history which has made a major contribution toward the development of a *new image of Man.*

In the pre-Darwinian literature, and also, in much of certain types of contemporary literature, man is conceived as a static being, created within an equally static nature that is subservient to him. Ever since Darwin this concept has increasingly been replaced by a new image, an image of an evolved and still evolving man, part of the evolutionary stream of the whole living world. And this new image, the direct product of evolutionary and natural history studies, is of critical importance, not only for our personal concept of the world in which we live, but also for such quite practical issues as man's relation to the environment, to the natural resources, and indeed even to the interaction among men.

It is about time we realize that the future of mankind is not something "written in the stars," something controlled by external forces, but that it is we humans ourselves who hold the fate of our species in our hands. We now have a fairly good idea what the major ills of mankind are and it has become quite clear that only a few of them are susceptible to purely technological solutions. Instead, most of them are of a behavioral-sociological nature and require a change in our value systems, a change one is not likely to accept unless one has a far better understanding of nature, of the dynamics of populations, of the biological basis of behavior, and of other components of the biology of organisms, than most of those have who are responsible for policy decisions.

It will require a deeper understanding of the mentioned problems and it will require massive education based on the findings that emerge from the type of researches that we are planning. During the planning of the wing we sometimes referred to it as a new "center for environmental and behavioral biology." Although this title was not officially adopted, it is indeed an apt

description of the focus of attention of the investigators in our new facility.

There may be some who have not kept up with recent developments in biology and who might consider it far-fetched to claim that the mentioned problems fall within the area of interest of systematics. And yet with systematics defined as the science of biological diversity and with the organism defined as something living and not merely a preserved specimen, a solid chain of links is formed from the systematics of Linnaeus through that of a Louis Agassiz to that of the modern evolutionary systematist and population biologist.

I add my vote of thanks to those who have made the creation of this new center of environmental and behavioral biology possible. I predict that it will have an impact on our knowledge and our thinking that will reach to the far corners of the earth.